Regional Scale Ground-Water Vulnerability Assessments in the Mid-Atlantic Region Based on Statistical Probability Models

A Multi-Scale

and

Multi-Threshold Approach

Investigators and Cooperators

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Presentation Outline

- Background and Research Objectives
- Model Development
- Some Results at Multiple -Scales and Multiple-Management Thresholds

Research Overview

ReVA Goal

… to develop and demonstrate an approach to comprehensive, regional-scale assessment that effectively informs decision-makers as to the magnitude, extent, distribution, and uncertainty of current and anticipated environmental risks.

USGS Goal

… to characterize the statistical relation between ground-water quality and geographic factors to generate shallow ground-water vulnerability maps at multiple-scales and at multiple management thresholds.

Spatial Statistics

- Subset of Statistics

- Area of Statistics Concerned with Making Inferences on Areas Between Data Collected at Various Points in Space

- Dependency of Point Data on Geographic Factors and can be Spatially Modeled

Defining The Problem
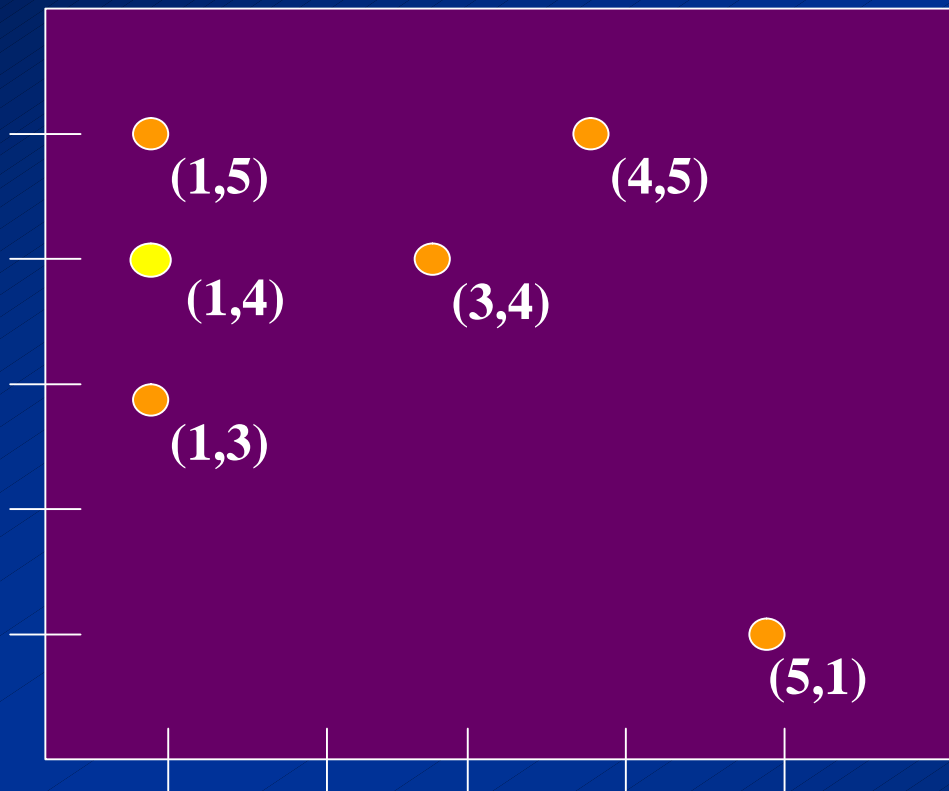
Values:

(1,5) = 100

(3,4) = 105

(1,3) = 105

(4,5) = 100

(5,1) = 115

(1,5)

(4,5)

(1,4)

(3,4)

(1,3)

(5,1)

Jay Ver Hoef, 2002

Output Maps

- **Probabilty Maps**
- **Standard Error Maps**
- **Confidence Interval Maps**
- **Quantile Maps**
- **Prediction Maps based on a Variable (Land-Use) Change**

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The Regional Model

- Uses only a Selected Database and Regional Spatial Statistical Method
- Nitrates are used as a Surrogate for Ground-Water Vulnerability
- Regional Ground-Water Vulnerability Maps
- Regional Error Maps
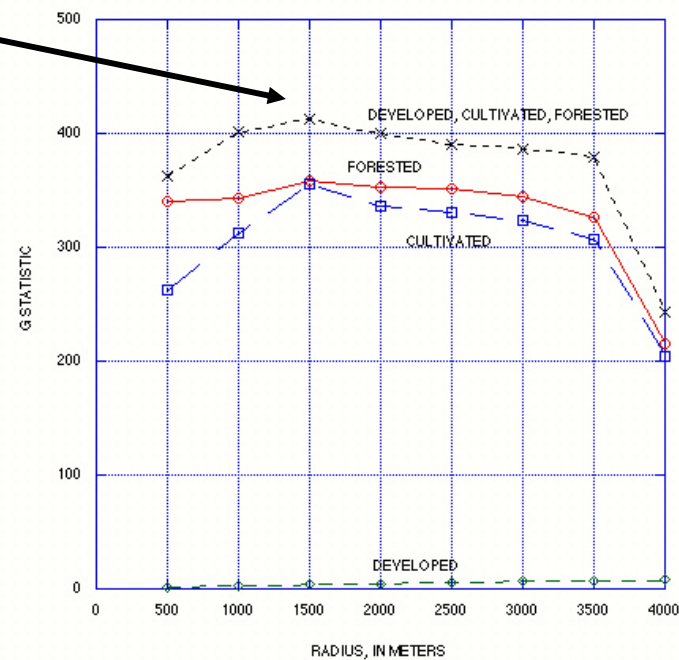
Map of the Mid-Atlantic region showing well locations
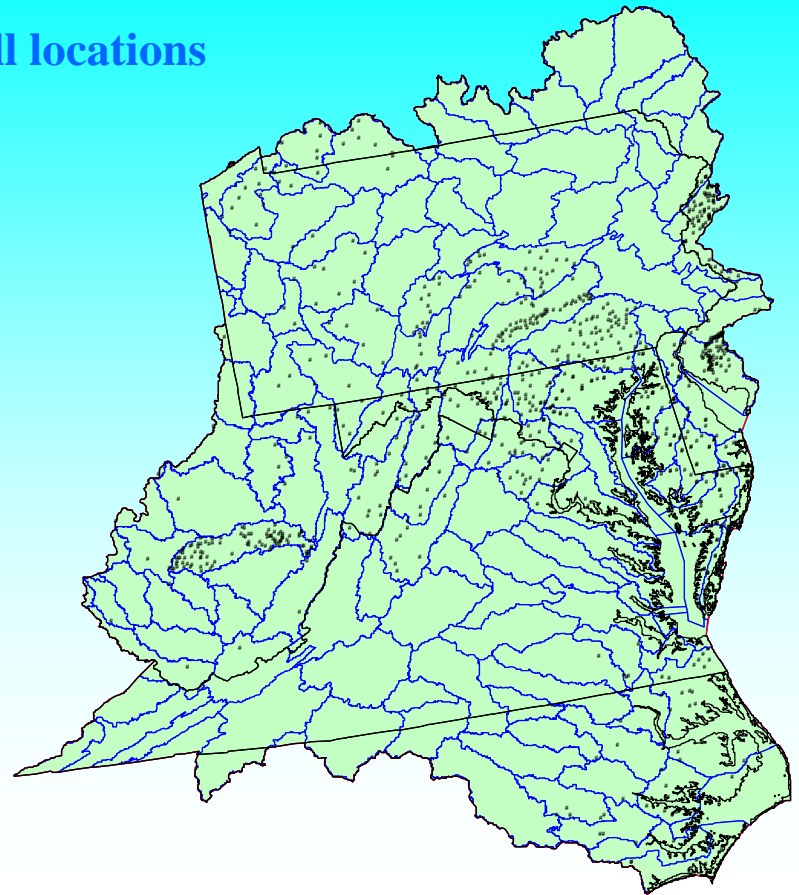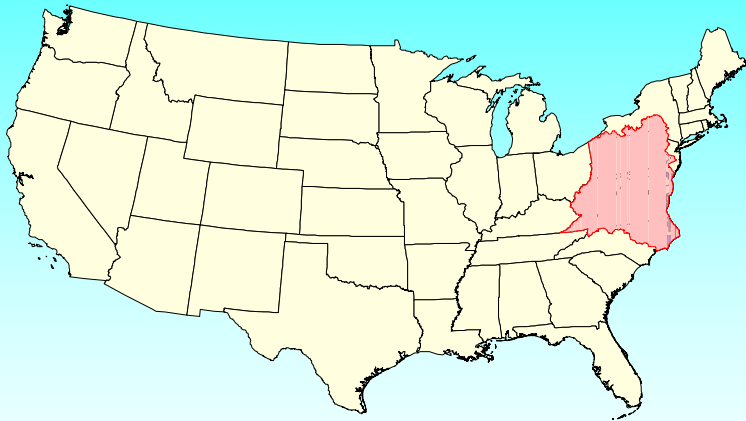
Statistically Grouped Land Use/Cover
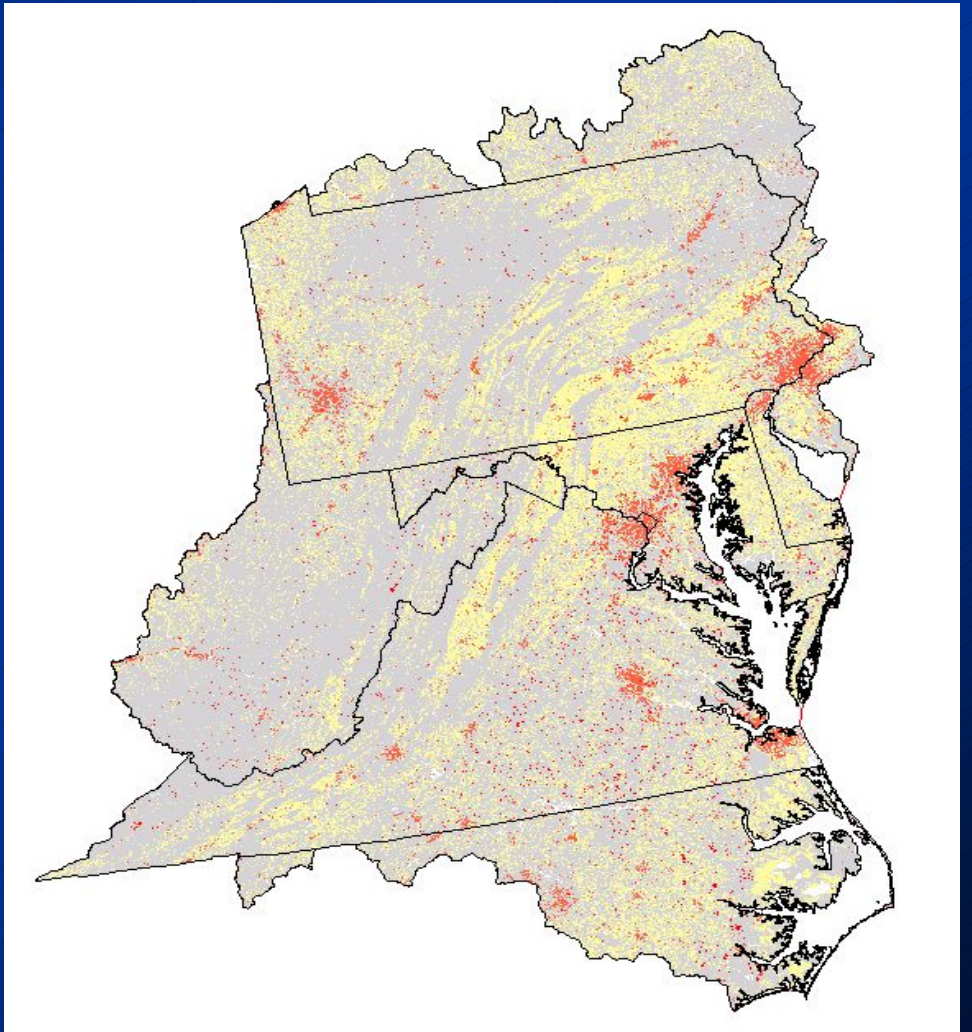
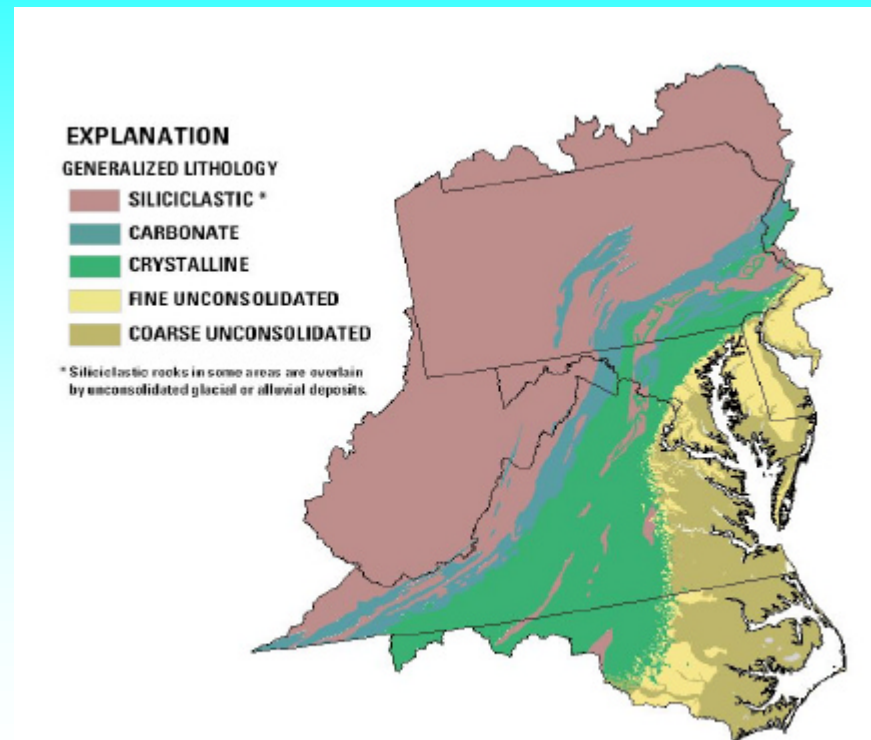# Spatial Dependency of Well Nitrate Concentration on Land Use

Radius is Maximized
at 1500 m

Generalized geology of the Mid-Atlantic region

Explored Variables in the Regional Model

- Land Use/Cover

- Geology Type

- Nitrate Input Function: Manure, Fertilizer, Atmospheric Deposition

- Soil Data: Hydrologic group, Organic Matter, Depth to Bedrock, Depth to Water Table, and Percent Silt and Clay

- Population Density

Understand Thresholds
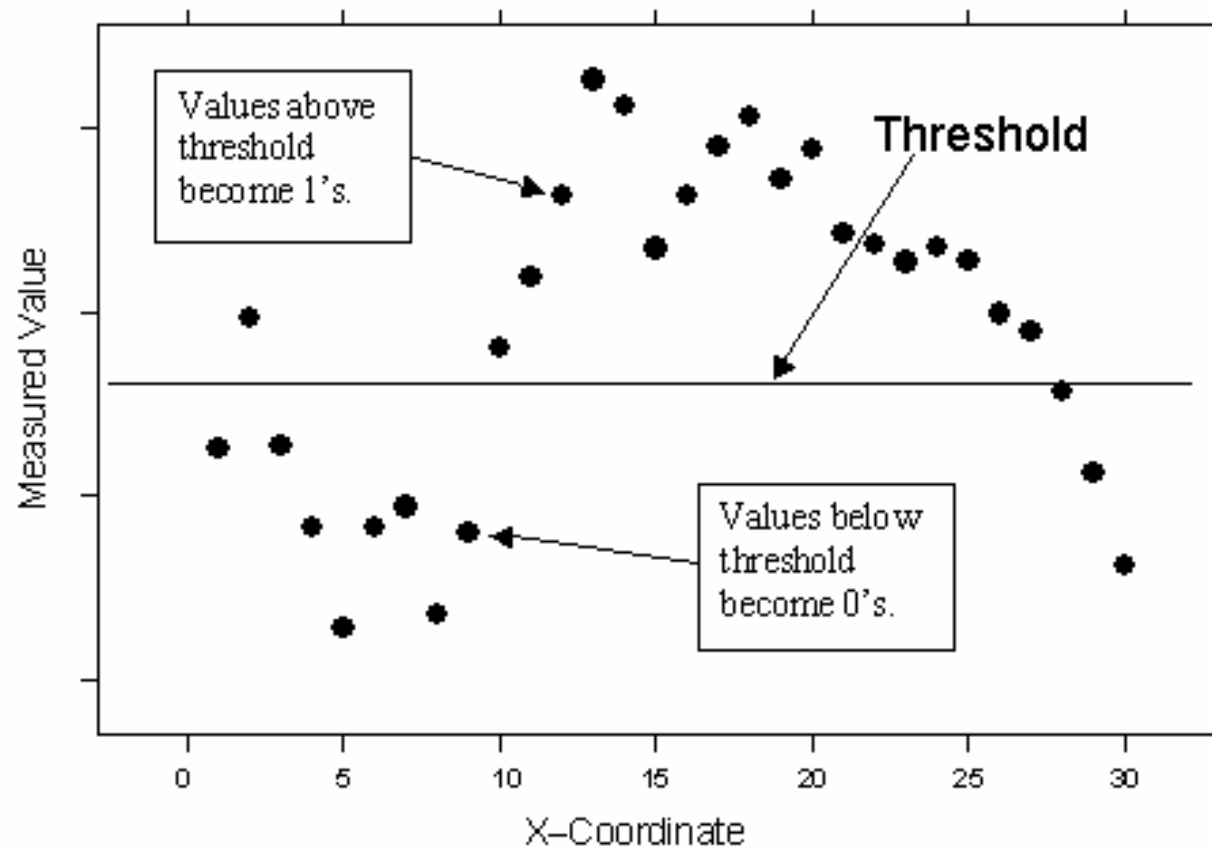
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Statistical Model Development

- Logistic-Regression method to predict the presence of nitrate concentrations above a specified management threshold value.

- Equations are developed using explanatory variables (land use, geology, soils, and other geographic datasets).

- Resulting equations are transformed to predict the probability of exceeding a specified management thresholds.
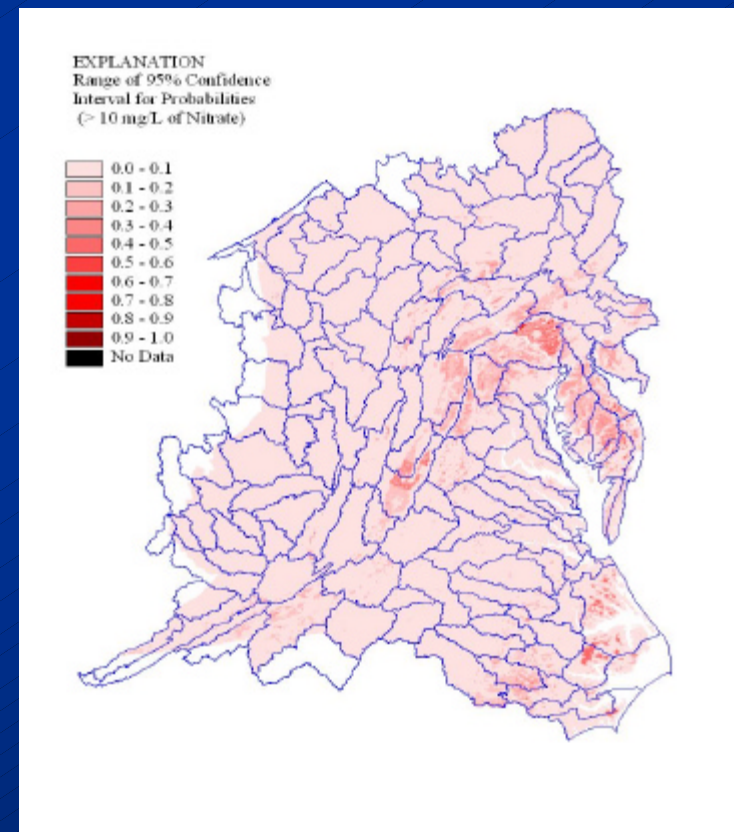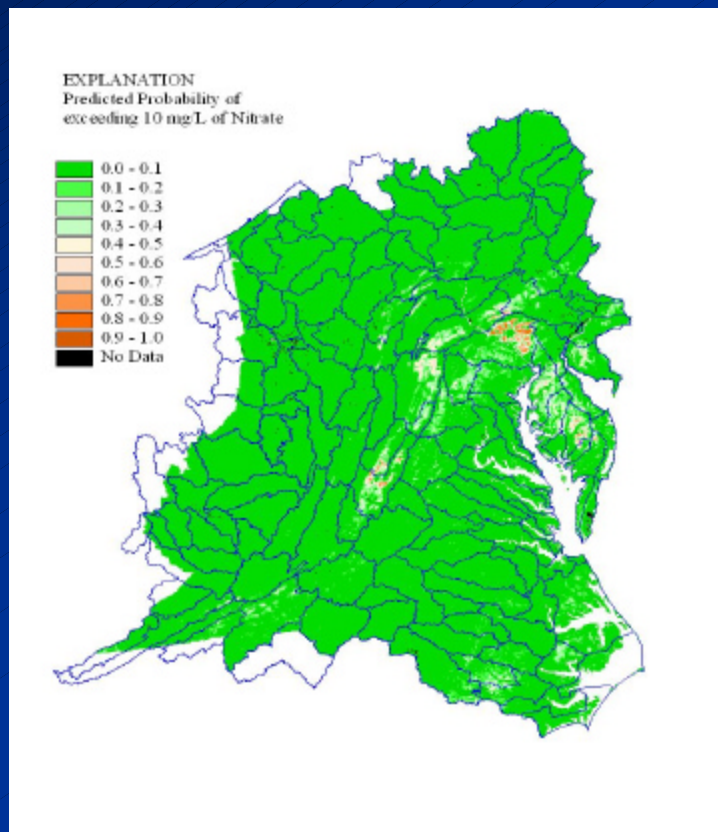
Presentation Outline

- Background and Research Objectives

- Model Development

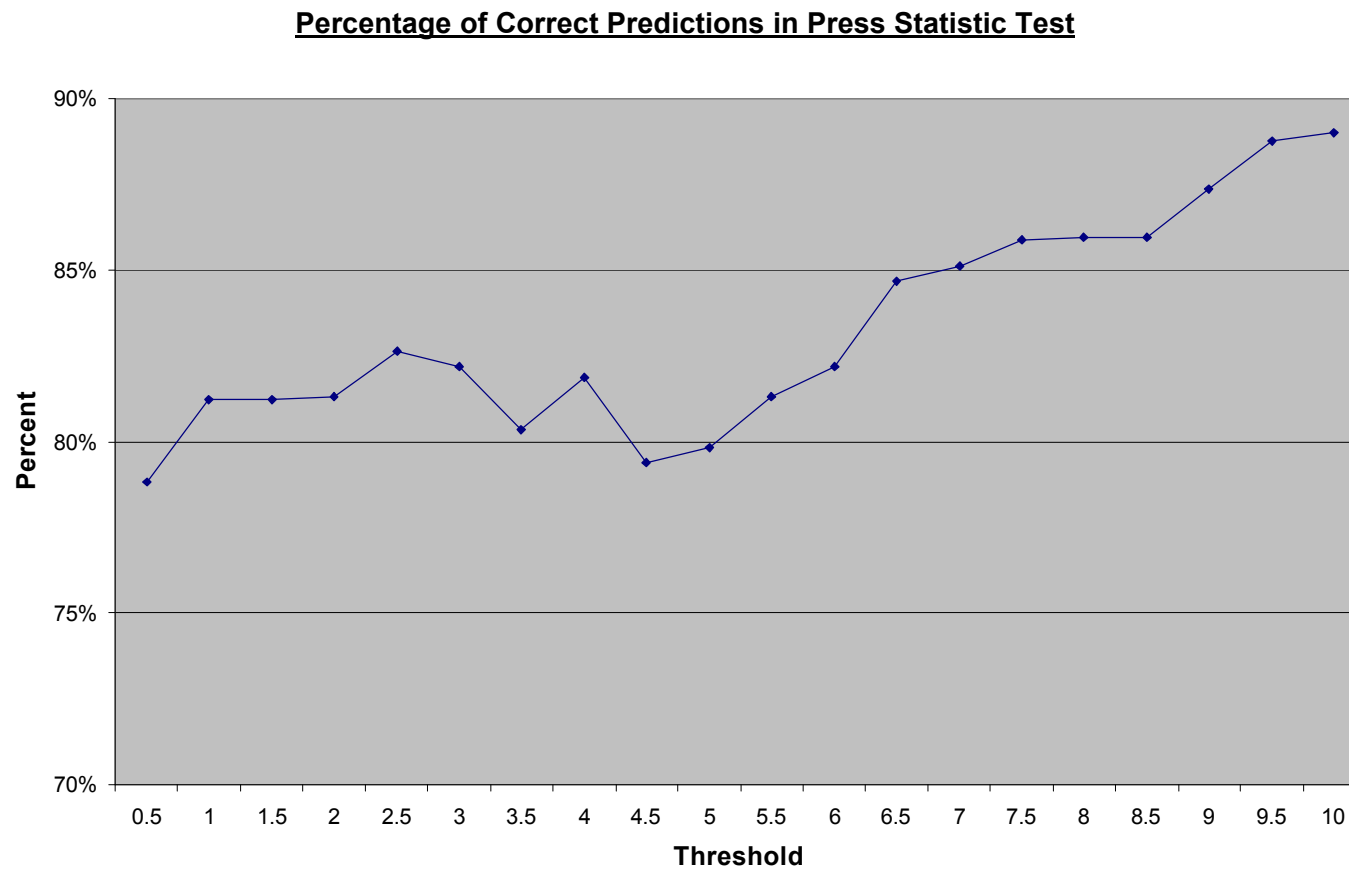- Some Results at Multiple -Scales and Multiple- Management Thresholds

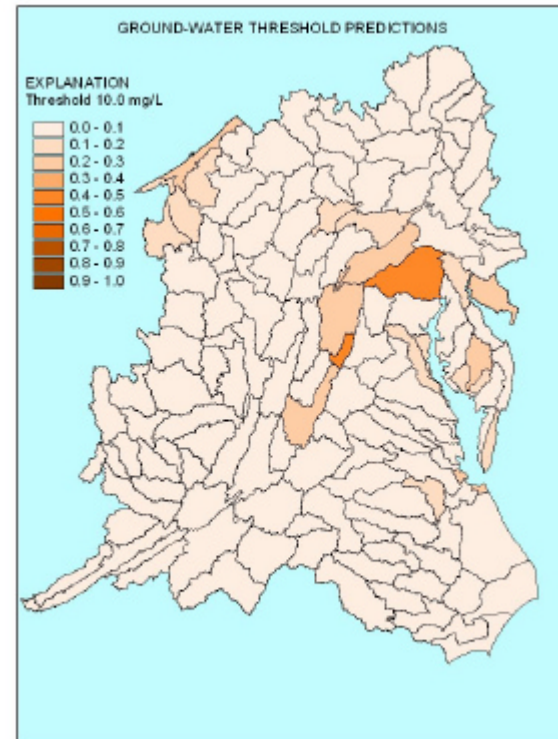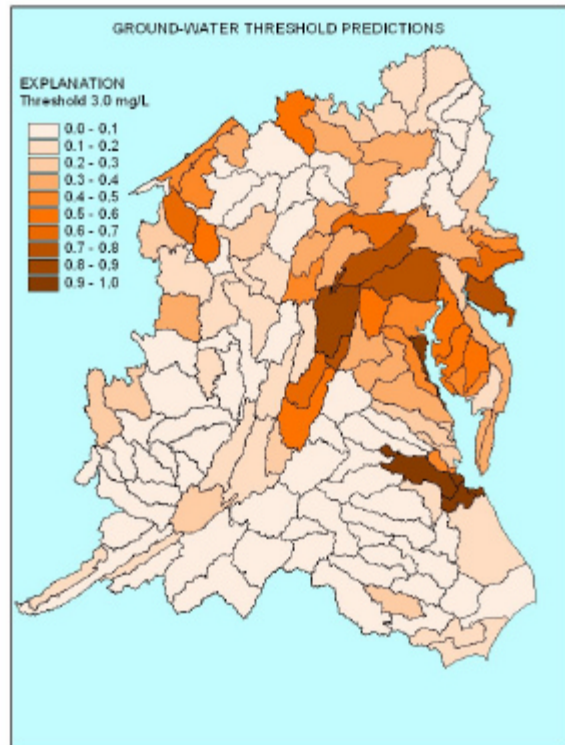# Regional Ground Water Vulnerability – Detail (1500m x 1500m) Scale
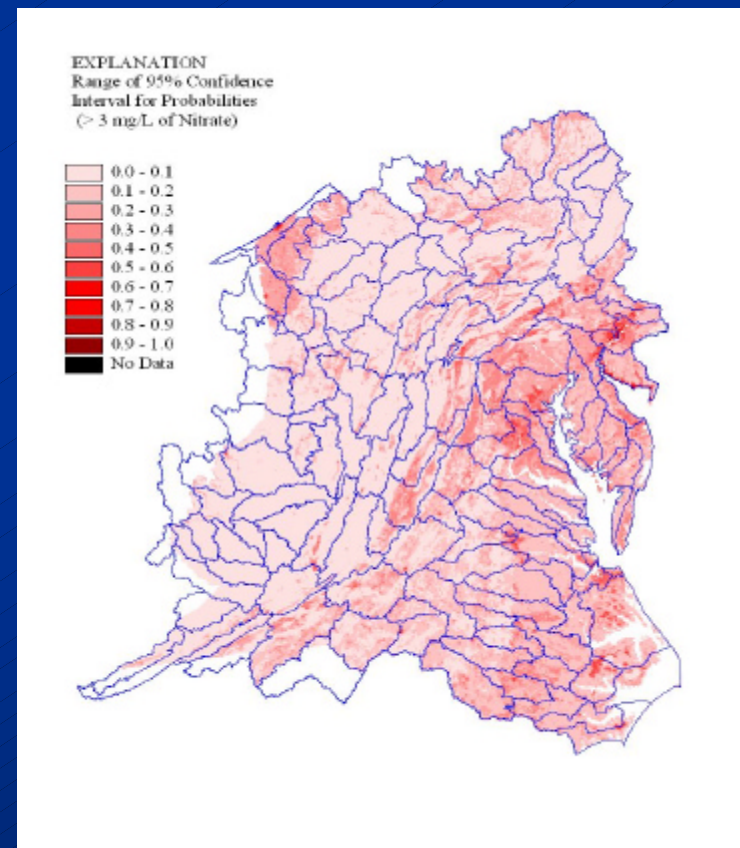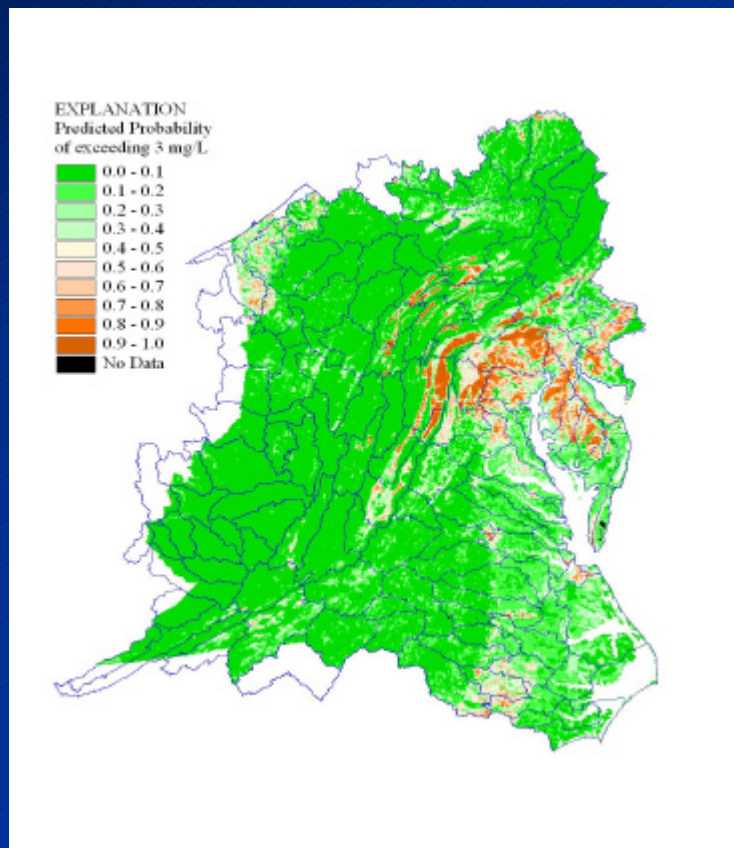
Regional Ground Water Vulnerability – Detail (1500m x 1500m) Scale

Predictive Power of Model Using the Press Statistic

Percentage of Correct Predictions in Press Statistic Test

Ground Water Vulnerability –Watershed Scale

Summary and Benefits to Resource Managers

- Improve our Knowledge of Ground-Water Quality and Vulnerability
- Develop Grid Scale (Detail Scale) Model
- Develop Watershed or County Based Specific Models
- Many Applications
  - Future Scenarios
  - Human Health
  - Monitoring Locations
  - Management